

DISPERSAL OF SQUARROSE KNAPWEED
(*CENTAUREA VIRGATA* SSP. *SQUARROSA*)
CAPITULA BY SHEEP ON RANGELAND IN JUAB COUNTY, UTAH

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Among *Centaurea* species naturalized in western North America, squarrose knapweed (*Centaurea virgata* Lam. ssp. *squarrosa* Gugl.) has a unique dispersal mechanism. The seeds (achenes) of other *Centaurea* species (*C. diffusa* Lam., *C. maculosa* Lam., *C. solstitialis* L., *C. jacea* L. × *C. nigra* L.) disperse either as individuals with crop seed, vehicles, and gravel, or as branches or entire plants moved by wind or vehicles, or in hay. Squarrose knapweed involucre bracts recurve or spread outward with a short terminal spine about 1–3 mm long. The entire head (capitulum) is deciduous via an abscission layer at the base of the capitulum. Thus, the capitula of squarrose knapweed function like burs clinging to passing animals as burdock (*Arctium minus* (Hill) Bernh.), cocklebur (*Xanthium strumarium* L.), or buffalobur (*Solanum rostratum* Dunal). Soon after the discovery of squarrose knapweed in California (1950) and in Utah (1954), its occurrence was linked to the practice of trailing rangeland sheep from one area to another (Bellue 1954, Tingey 1960). On Utah rangeland squarrose knapweed is more abundant along sheep trails and on bedgrounds than in other areas (H. Gates and T. Roberts, personal communication). Wool is ideally suited to catching and holding the burlike capitula, but squarrose knapweed along trails and in sheep bedgrounds may have been carried by vehicles or other means and established in soil disturbed by sleep. The objective of this study was to determine if the distribution of squarrose knapweed in Utah is due to seed carried in the wool of rangeland sheep.

METHODS AND MATERIALS

In mid-April 1990, sheep examined in this study were trailed from winter range west of Tintic Junction, Juab County, Utah, and sheared before being moved to spring range. We received permission from the owners to collect wool samples during shearing of a band that had wintered on rangeland known to have squarrose knapweed. We had predicted that sheep would pick up the “burs” by lying on or brushing against knapweed plants growing on their bedgrounds. However, we saw no obvious knapweed capitula in belly wool or on the sides of sheep being sheared. One shearer pointed out several ewes with a profusion of knapweed capitula around their faces and on top of their heads (Fig. 1). We then collected samples of topknot wool (that shorn from the top of the head) from 458 randomly selected white ewes from a band of approximately 2500 ewes at the Jericho shearing station in Juab County, Utah. Black ewes were not sampled. Samples from individual ewes, averaging 10 g, were kept separate in small plastic bags. Squarrose knapweed capitula were sorted by hand from each sample, and the number of achenes per capitulum was recorded. Filled achenes (hard, plump, dark tan or brown achenes) and light achenes (softer, flatter, pale tan or whitish achenes) were recorded separately. Presence or absence of insect galls (*Urophora affinis* Frauenfeld and *U. quadrifasciata* [Meigen]) in the knapweed capitula was noted.

Achene viability was determined with germination trials run for 10 days at 20 C, 12 hours

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Fig. 1. Numerous squarrose knapweed capitula were caught as burs in the topknot wool of sheep that had wintered where squarrose knapweed occurred on rangeland in Juab County, Utah.

TABLE 1. Proportion of capitula containing 0–6 achenes per capitulum, comparing all capitula from an intact plant with sheep-gathered capitula removed from topknot wool, in Juab County, Utah.

Achenes/capitulum	Intact plant %	Extracted from wool %
0	14	75
1	12	18
2	19	6
3	35	1
4	17	trace
5	3	0
6	trace	0

light alternating with 12 hours dark. Seeds were placed in germination boxes on wetted blotter paper. Filled and light achenes were tested separately. We germinated 30 filled achenes in four replications in each of two trials. Two trials of light achenes were run with 20 seeds in each of two replications.

In August 1989, a squarrose knapweed plant with all of its capitula was collected in a bag. We dissected the capitula and recorded the number of achenes per capitulum. These values were

compared to capitula and achenes found on sheep.

RESULTS

We determined that sheep on rangeland infested with squarrose knapweed picked up and carried its burlike capitula. Squarrose knapweed capitula were present in topknot wool samples from 73% of the ewes. A total of 2469 knapweed capitula were recovered from the 458 ewes, an average of 5.5 capitula per 10 g wool. Most capitula were on the wool surface, although a few were embedded deeply and appeared to have been there longer as they were saturated with lanolin and spines had worn off the involucre bracts.

Seventy-five percent of the sheep-gathered capitula were barren, compared with 14% of the capitula produced on a whole plant (Table 1). Only 49% of the wool samples that contained capitula had one or more achenes. Barren capitula in this study were not the result of biocontrol insects because we found no insect galls.

The number of knapweed capitula on sheep



Fig. 2. Squarrose knapweed plants along the sheep trails west of the Jericho shearing station were grazed in mid-April 1990. A few capitula remain on the upper right side of the plant.

heads would lead a casual observer to conclude that the sheep carry more achenes than we found by dissecting the capitula. Among all ewes sampled, only 36% carried achenes in the sampled topknot wool. These seed-carriers averaged 4.5 filled achenes per 10 g wool. Those filled achenes averaged 69% germination. In addition to the filled achenes, 5% of the light achenes germinated. Light achenes composed only 23% of the total number of achenes.

DISCUSSION

Sheep carried squarrose knapweed capitula but not as many achenes as the number of capitula would indicate if the proportion were the same as that estimated in August. This finding could indicate one of two conditions: (1) the capitula were picked up in late winter or early spring, when only the lighter capitula remained on the plants, or (2) some achenes were lost from capitula lodged in the wool during late summer or fall. In late summer heavier capitula are more easily dislodged from plants than are the lighter capitula. Capitula do not open widely at maturity; instead, achenes sift out through a

small opening created as the dried flowers fall from the capitulum. The proportion of empty capitula increases with time following maturity as plants are shaken by wind, animals, or vehicles.

Sheep acquired knapweed capitula in a manner different from what we had predicted. Although some capitula cling to sheep brushing against plants or lying upon them, the numerous knapweed capitula in the wool around their faces suggest that ewes searched out squarrose knapweed as a food source. We observed that squarrose knapweed plants along the sheep trails had been grazed (Fig. 2). This relationship was mutually beneficial for knapweed and sheep, providing propagule dispersal for the knapweed and nourishment for the sheep.

Previously reported to be poor forage (Tingey 1960), squarrose knapweed rosette leaves may be an excellent source of protein in late winter and early spring. Nutrient content of spotted knapweed rosette leaves is comparable to native forage plants with 9–18% crude protein (Kelsey and Mihalovich 1987). Similar values have been obtained for diffuse knapweed and yellow starthistle rosette leaves (Roche, unpublished data). In the study area, September 1989 through May 1990 was unusually dry (Utah State University Tintic research site weather station, unpublished data), and the normal growth of cheatgrass (*Bromus tectorum* L.) was not present on the winter range. Squarrose knapweed, a deep-rooted perennial forb, was one of the few plants exhibiting new growth at the time sheep would normally forage on cheatgrass.

Although we found that sheep carry squarrose knapweed seeds as they move across rangeland, they are by no means the only dispersal mechanism for squarrose knapweed. Other animals, both domestic and wild, may carry knapweed seeds. In addition, these rangelands are heavily used by off-road vehicle recreationists. Mining traffic, railroad activity, and military maneuvers are important in certain areas. Hunters, rockhounds, and other recreationists also frequent the area.

Shearing limits the dispersion of squarrose knapweed by sheep. It is unlikely that knapweed achenes remained on sheep after shearing. These ewes had not yet lambed, and so all sheep in this band left the knapweed-infested winter range shorn of seeds. Seeds in the wool are removed at the woolen mill, which has been one of the fates of squarrose knapweed seed for

centuries, as evidenced by squarrose knapweed found at Juvénal Gate, a woolen mill in France where imported wool was washed for 200 years, beginning in 1686 (Thellung 1912).

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